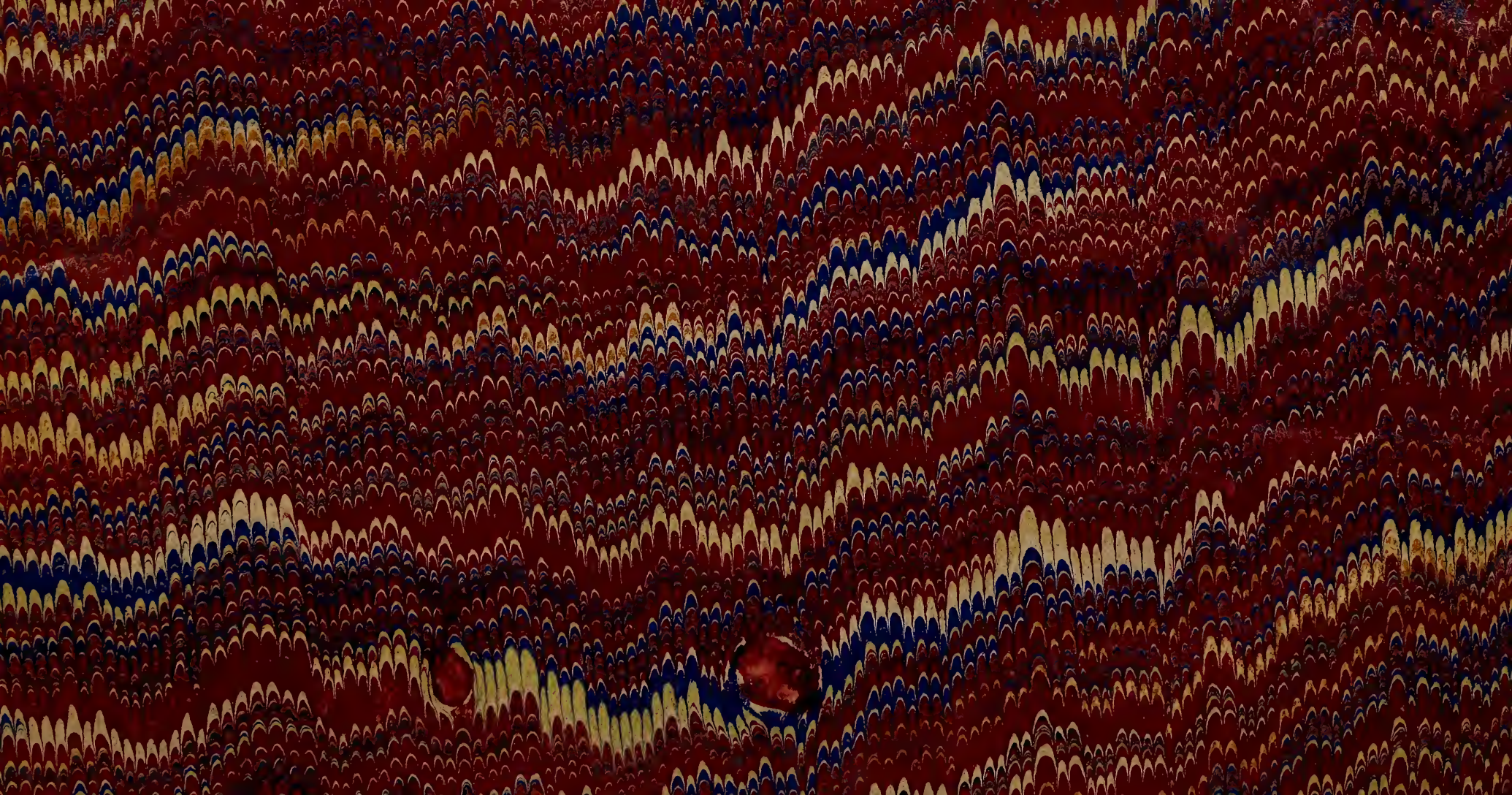

United States Hydrographic Office.—Bureau of Navigation.

[-9]

HURRICANES;

WITH

NAUTICAL DIRECTIONS FOR AVOIDING

AND

MANEUVERING IN THEM.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1872.

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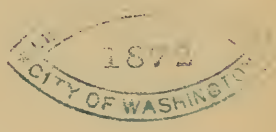

MANEUVERING IN THEM.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1872.

The following extracts are from the valuable works of the late C. Phillipe de Kerhallet, captain, French navy, &c., and from the Memoirs on Hurricanes, &c., by Mons. M. Keller, hydrographic engineer, French navy:

R. H. W.

UNITED STATES HYDROGRAPHIC OFFICE,
April 2, 1872.

Hurricanes.

Hurricanes* take place in the three great seas of the globe: the Atlantic, the Indian, and the Pacific Oceans.

In the Atlantic Ocean, the West Indies is the center of the most terrible hurricanes known. In the Indian Ocean it is about the position of Rodriguez, Mauritius, and Réunion Islands. In the Pacific, where very few observations have thus far been made, it is supposed to be in the vicinity of the Tonga Islands.

Period of hurricanes.

In the West Indies and their vicinity, the season during which hurricanes may be expected includes the months of August, September, and October;† at this period the navigation of the West Indies, of the Gulf of Mexico, and south coast of the United States should be avoided as much as poss

If it is necessary to winter in these localities, a perfectly protected port should be chosen. Hurricanes seldom occur in June or July.

In the Indian Ocean, hurricanes take place from December to April; that is, during the warmest months of the southern hemisphere; they seldom occur in November and in May, and are unknown during the other months of the year.

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* For a more complete description of hurricanes, &c., we would refer mariners to the excellent treatise of M. Keller, hydrographic engineer, Paris. *Traité sur les Ouragans, &c.*, and also to *Silliman's Journal;* to Reid, *Attempt to Develop the Laws of Storms;* to Thom, *Inquiry into the Nature and Laws of Storms;* to Piddington, *Horn-Book of Storms, Observations on Revolving Storms, British Admiralty;* and the *Memoir on the Storms of the East Indies*, by Lieutenant Lefebvre.

† According to Blodget: Climate of the United States, (p. 400,) from observations extending over nearly four centuries, hurricanes have occurred in the West India Islands and their vicinity in the following ratio per 100 for the different months of the year:

January, 1.5; February, 2; March, 3; April, 2: May, 1.5; June, 3; July, 7; August, 28.5; September, 24; October, 20.5; November, 5; December 2.

In the Pacific Ocean, to the south of the Equator, the known hurricanes have taken place in November and in December, and they appear to have much similarity to those of the Indian seas.

The supposed extent of the zones where hurricanes are met with.

In the Atlantic Ocean, to the north of the Equator, the supposed extent of the zone where hurricanes are experienced is comprised between the latitude of 10° and 50° N. and the longitude of 50° and 100° W.

In the Indian Ocean, the extent of this zone in longitude is three thousand miles, from the west coast of Australia to that of Madagascar, and is comprised between the latitude of 6° or 8° S. and 22° S.

Having indicated the different treatises published on hurricanes, we cite particularly that of M. Keller and the memoir of M. Lefebvre, and would refer all seamen who may wish to familiarize themselves with the manner in which the general laws of storms are deduced from theory, as also the practical rules for escaping their violence, to these works. This subject does not enter into the plan of this memoir, in which we only state facts without searching for the causes. We will limit ourselves to giving the general laws of hurricanes, as deduced from numerous observations, together with practical directions.

These tempests have a double movement; the one gyratory, or rotary, the other of translation, or movement from one place to another.*

Gyratory movement.

To the north of the Equator the gyratory movement is from the right to the left in passing by the N.; that is to say, in an opposite direction to the movement of the hands of a watch. In the southern hemisphere on the contrary, it is from left to right in passing by the N., or in the same direction as the movement of the hands of a watch.

Movement of translation.

The movement of translation is upon a parabolic curve, the apex of which is always turned toward the W., and the branches throw themselves out to the E. The apex of this curve is tangent to the meridian about the latitude of 30° in the northern hemisphere and about that of 26° in the southern hemiphere; that is to say, nearly at the polar limits of the trade-winds. The hurricane moves on this curve in departing from the Equator; in other words, the point of departure of the hurricane is at the eastern extremity of the curve of its path nearest approaching the Equator, and in a latitude nearly equal to the declination of the sun; from thence, the hurricane, in the first half of

* The following is taken from the treatise of M. Keller.

its course, is directed toward the apex of the curve, or toward the W.; then it follows this apex as tangent to the meridian, bending afterward to the E., in the portion of the curve of its path the farthest removed from the Equator.

Velocity of translation.

The velocity of the translation is in proportion to the violence of the tempest. In the mildest hurrricanes observed it has not been less than ten miles an hour, and in the most violent it has not exceeded thirty miles.*

Diameter of the vortex.

Nearly all authors on this subject, observes M. Lefebvre, have sought to measure the diameter of the vortex, and, this diameter being known, to determine from the force of the wind and the falling of the barometer at what distance the observer was from the center. They have succeeded but indifferently; the diameter of the vortex of hurricanes is very variable. M. Keller states that the initial diameter of the gyratory movement is from 3° to 4° of the terrestrial arc, and that it increases progressively as it advances, until it attains 8° or 9° at the extremity of the curve of its path.

Dangerous semicircle.

In the northern hemisphere, the vessels placed on the edge of the right parallel to the path of the center, and in the southern hemisphere those placed on the edge of the left, are those most injured.

A ship surprised by a hurricane perceives successively every direction of the rotary movement of the air on a secant parallel to the path of the center of the meteor;† these changes of direction never make the tour of the compass. When the secant traverses the center of the meteor the wind changes sixteen points at the center perpendicularly to the line of translation, and after an interval of calm.

Oscillations of the barometer.

On each secant the barometer falls gradually to the instant of the passage of the point nearest the center, then it rises progressively from this moment until the end of the tempest, which corresponds to the extremity of the secant. But, says M. Lefebvre, the violence of the wind is no more connected with the diameter of the vortex than the fall of the barometer is. The wind increases as the center is approached, and the barometer constantly falls; this is all

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*M. Lefebvre states that for the Indian Ocean these velocities are too great, and he estimates for the movement of translation a velocity of from five to six miles an hour, as a mean, for, he adds, hurricanes do not change their place but at a rate of velocity of two miles per hour.—*Mémoir on the Hurricanes of the Indies, &c.*, page 12.

† Some authors state that in these tempests the wind attains a velocity of even ninety miles an hour.

that can be said. To attempt to establish a general rule on this point would most likely lead to error.*

Such, according to M. Keller, are the laws principally observed in hurricanes. These laws known, the attempt has been made to utilize them, and to give to seamen the means of avoiding the violence of these terrible phenomena. The two problems to solve were these: 1st, to determine in a hurricane the position occupied by the vessel in relation to the movement of translation of the meteor; 2d, this position known, to determine which may be the best maneuver to make to receive the hurricane or to cross it in the manageable semicircle. The first problem is easily resolved, and M. Keller has given us on this subject a very important general rule which can be applied to every type of tempest, whether they have a convergent or divergent character; that is to say, whether the wind in turning describes a circle, or whether it is directed from the circumference to the center of the vortex or from its center toward the circumference.

The following is the principle on which can be determined in every case whether you are to the right or to the left of the path of the storm:†

"Every vortex, in moving, causes to be felt at fixed points on its passage to the left of the path of its center a successive change of wind, turning by compass to the left, or in an opposite direction to the movement of the hands of a watch. It causes to be experienced at points situated to the right of this path a succession of winds which turn by the compass to the right, with the movement of the hands of a watch."

Thus, when a hurricane threatens, by remaining one or two hours in nearly the same position, and observing with great care the successive variations of the wind, the position of the vessel with regard to the line of its path can be determined without difficulty, and consequently whether you are in the dangerous or manageable semicircle.

In hurricanes of a rotary type it is very easy to determine the bearing of the center of the tempest with regard to the vessel. We have said, in effect, that in these tempests,

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* *Memoir on Hurricanes, &c.*, page 11.

† *Memoir on the Typhoon of 11th to 14th September*, 1840, page 3. In a memoir much more comprehensive, which includes the researches made by M. Keller on hurricanes, which is yet unpublished, the principle which we give here in so condensed a shape will be accompanied by explanations, &c., which will demonstrate its correctness and its practical application.

to the north of the Equator the wind turns from right to left, contrary to the movement of the hands of a watch, and that to the south of the Equator it turns from left to right. Then whatever may be the space occupied by the tempest, the wind blows always in describing a circle. Evidently the center of this circle should be found on the perpendicular to the direction of the existing wind. Consequently, it is sufficient to determine by compass the direction of the wind, and the center will be 90° to the right, if in the northern hemisphere, and 90° to the left, if in the southern hemisphere.

In order to avoid error in this particular, the following table can be used, which gives at once, from the direction of the wind, the bearing of the center of the storm for each hemisphere:

Northern hemisphere.		Southern hemisphere.	
If the wind is—	The center bears—	If the wind is—	The center bears—
N	E	N	W.
N. by E	E. by S	N. by E	W. by N.
N. N. E	E. S. E	N. N. E	W. N. W.
N. E. by N	S. E. by E	N. E. by N	N. W. by W.
N. E	S. E	N. E	N. W.
N. E. by E	S. E. by S	N. E. by E	N. W. by N.
E. N. E	S. S. E	E. N. E	N. N. W.
E. by N	S. by E	E. by N	N. by W.
E	S	E	N.
E. by S	S. by W	E. by S	N. by E.
E. S. E	S. S. W	E. S. E	N. N. E.
S. E. by E	S. W. by S	S. E. by E	N. E. by N.
S. E	S. W	S. E	N. E.
S. E. by S	S. W. by W	S. E. by S	N. E. by E.
S. S. E	W. S. W	S. S. E	E. N. E.
S. by E	W. by S	S. by E	E. by N.
S	W	S	E.
S. by W	W. by N	S. by W	E. by S.
S. S. W	W. N. W	S. S. W	E. S. E.
S. W. by S	N. W. by W	S. W. by S	S. E. by E.
S. W	N. W	S. W	S. E.
S. W. by W	N. W. by N	S. W. by W	S. E. by S.
W. S. W	N. N. W	W. S. W	S. S. E.
W. by S	N. by W	W. by S	S. by E.
W	N	W	S.
W. by N	N. by E	W. by N	S. by W.
W. N. W	N. N. E	W. N. W	S. S. W.
N. W. by W	N. E. by N	N. W. by W	S. W. by S.
N. W	N. E	N. W	S. W.
N. W. by N	N. E. by E	N. W. by N	S. W. by W.
N. N. W	E. N. E	N. N. W	W. S. W.
N. by W	E. by N	N. by W	W. by S.

The bearing of the center of a hurricane from the vessel being known, it is certainly desirable to determine its dis-

tance; for this, however, no precise rule has as yet been found. Some very good inferences may be drawn from the quickness or sluggishness with which it appears to develop itself, from the increasing violence of the squalls, from the irregularity of the sea which rises in several directions, and above all from the rapid variations of the barometer.

A remarkable trait of the rotary gale is the increase of the wind in the vicinity of its center, although at the center itself it blows so irregularly and by squalls as to render it impossible for a ship to complete a maneuver. The nearer the center is approached the more sudden are the changes of the winds, which, instead of shifting point by point, as is the case at the entrance of the circle of the tempest, it shifts all at once sixteen points. The ship is enveloped in a terrible squall, and gathers stern-board against a frightful sea, the disastrous consequences of which it would be unnecessary to detail.

The undulations and currents of hurricanes appear to be the constant results of these violent atmospheric shocks. These two phenomena deserve to be the subject of serious study and research.

Undulations of the hurricane.

The undulation of the hurricane is a mass of water of greater or less diameter, according to the force of the tempest raised above the ordinary level of the ocean by the atmospheric pressure or other cause. This mass is driven before the storm in its course until it encounters some obstacle, as the mouths of rivers, bays, or coasts, when it often produces serious inundations or heavy bores.

Currents of the hurricane.

The currents of a hurricane can be briefly defined as circular currents, where the tempest is of a rotary type.

There are also in every hurricane two forces, independent of that of the wind, which act upon a vessel, the one drawing her directly in the line of the path of the storm, the other drawing her toward the circumference of that portion of the rotary circle where she is placed; thus, while the drift due to the undulation of the hurricane sets toward the W., the current of the hurricane will set toward the W. on the northern portion of the rotary circle; it will set to the E. on the southern part of this circle, to the S. on the western portion, and to the N. on the eastern portion of the same circle. If the rotary motion is from E. to W. passing by the N., as in the hurricanes of the northern hemisphere, the rotary motion would be in the opposite direction in the hurricanes of the southern hemisphere.* Electricity seems to

*Inquiry into the Nature and Course of Storms.

take a great part in hurricanes, though very often it may escape observation.

Among the thirty-two hurricanes of the Indian Ocean, of which the *data* is precise, eleven have been accompanied by thunder and lightning, while in twenty-one no electric phenomena were observed. Thom says * that these phenomena are five times more frequent on the north side of the curve of translation of hurricanes than on the south side; that is, in the position where the monsoons of the W. prevail. He adds that it was so common for lightning in the N. and N. W. to precede a gale that the Dutch captains when going from the Cape of Good Hope to India had orders to reduce sail and take every precaution when they saw lightning.

In addition to the menacing aspect of the sky which generally precedes all storms, that thick circle around the sun or moon, clouds heaped up and distended with their gloomy lines of light and their fantastical colors, often of copper color, forming a heavy curtain at the horizon, with menacing points and lines of pale lightning, is known to every sailor. These clouds rise little by little, covering soon the whole horizon. In approaching the zenith, squalls form before the strength of the tempest, the rain falls in torrents, and at the same time the hurricane bursts. †

The barometer and sympiesometer are most valuable instruments in the region of hurricanes, and should be attentively consulted. In these regions a great fall of the mercury below its ordinary level never takes place without being followed by a tempest. We have given above its course in hurricanes.

Heavy rains always accompany tempests of a rotary type. At a distance of one hundred miles from each side of the rotary circle, there is a heavy bank of clouds giving out torrents of water without interruption, and this during several weeks.

Hurricanes seldom penetrate into the Gulf of Mexico, though three or four have ravaged its coast, and reached as far as Vera Cruz; among others, that of 18th of August, 1810, and that of 23d of June, 1831.

NAUTICAL DIRECTIONS TO AVOID HURRICANES.

EXTRACT FROM THE MEMOIR OF M. KELLER.

We will recapitulate for each hemisphere the nautical directions for attempting to avoid the violence of hurricanes,

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* *Horn-Book of Storms.*

† Hurricanes, Tornadoes, Typhoons, and Tempests, &c.

in order to facilitate their application by navigators threatened to be enveloped by these storms.

IN THE NORTHERN HEMISPHERE.

Hurricanes of West Indies, Cyclones of India, Typhoons of the China Sea.

"If the wind hauls by the compass to the right, or in accordance with the movement of the hands of a watch, you are in the dangerous semicircle of the tempest, and, whatever may be the latitude, you should heave-to on the starboard tack, or, if the force of the wind is not too great, stand on close-hauled on the starboard tack.

"If, on the contrary, the wind hauls by the compass to the left, or in an opposite direction to the movement of the hands of a watch, you are in the manageable semicircle of the tempest; and, if the sea is not too heavy, you should run with the wind on the starboard quarter, or, if the sea is too heavy, heave-to on the port tack."

IN THE SOUTHERN HEMISPHERE.

Hurricanes in the Channel of Mozambique, Island of Bourbon, &c.

"If the wind hauls by the compass to the left, or in a direction opposite to the movement of the hands of a watch, you are in the dangerous semicircle of the tempest; and, whatever be the latitude, you should heave-to on the port tack, or, if the storm is not too heavy, stand on close-hauled on the port tack.

"On the contrary, if the wind hauls by the compass to the right, or in accordance with the movement of the hands of a watch, you are in the manageable semicircle of the tempest; and, if the sea is not too heavy, run with the wind on the port quarter. If the sea becomes too heavy, heave-to on the starboard tack.

"We will further add that, after having experienced a hurricane in less than 26° S. or 30° N. latitude, you should not for some days steer toward the Pole, to avoid again encountering the branch of its path the farthest removed from the Equator; for although the velocity of its movement exceeds greatly that of a ship, yet the latter may describe the chord which joins two points of the curve of the hurricane in the same time employed by the meteor to run over the arc of this chord.

"This precaution would be superfluous in the hurricanes

of the Gulf of Bengal and in the typhoons of the China seas, for these seas only extend to 30° N. latitude, and only contain a limited and sensibly rectilineal portion of the general path of hurricanes, which spend themselves on the land when directed toward the N. W.

"These practical directions are independent of the latitude; they apply to all the routes of typhoons and assure escape in the right direction when this is possible."

EXTRACT FROM A SUBSEQUENT MEMOIR OF M. KELLER, RELATING TO MANEUVER IN HURRICANES, CYCLONES, TYPHOONS, AND TEMPESTS.

"The gyratory movement of hurricanes determines the tack.

"The movement of translation decides the course a ship should take.

"In the northern hemisphere the gyratory movement is opposite to the movement of the hands of a watch, and in the southern hemisphere it is in the same direction as that movement.

"The gyratory movement being invariable in each hemisphere, the tack upon which a ship should be placed is equally invariable. It is the starboard in the northern hemisphere and the port in the southern hemisphere.

"The movement of translation of the hurricane determines for both hemispheres:

"1. In the dangerous semicircle, the course close-hauled, as long as the barometer falls, and with the wind free when it rises.

"2. In the manageable semicircle, the course with the wind on the quarter as long as the barometer falls, and with the wind free when it rises.

"The dangerous semicircle being to the right of the path of the center in the northern hemisphere and to the left in the southern hemisphere, the course of escape—that is to say, the route which should be pursued to increase the distance from the center of the hurricane—will be known, if it is known on which side of the path of the center of the hurricane the ship is placed; now the side is indicated by the variation of the wind by the compass, produced by the change of the place of the center of the storm.

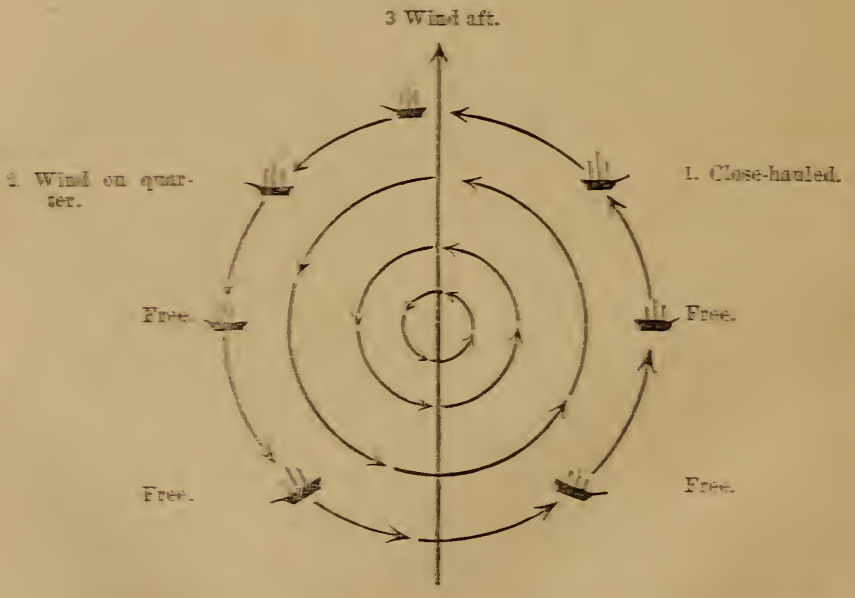
"If in looking in the eye of the actual wind, the wind as it hauls blows from the right, the ship is to the right of the path of the center. If, on the contrary, the wind as it hauls blows from the left of the actual wind, the ship occupies a position to the left of the path of the center; after this, the route to be pursued to increase the distance from the center depends exclusively on the variation of the wind.

"This variation should be observed hove-to, in order that it be the result of the change of the base of the cyclone, and not the change of position of the ship; besides, it should correspond to a fall of the barometer, a distinctive mark of the actual penetration of the ship into the body of the hurricane.

"The indications of the approach of a hurricane being a heavy swell, a steady fall of the barometer, and an increasing violence of the wind, as soon as these are observed, a ship should reduce sail and be hove-to on the starboard tack in the northern hemisphere and the port tack in the southern hemisphere, without taking into consideration the direction of the waves, in order to escape the center of the storm and be in a position to execute, at once, such ulterior maneuvers as the variation of the wind, observed while hove-to, may determine. A *résumé* of these maneuvers is given in the following:

MANEUVER IN HURRICANES IN THE NORTHERN HEMISPHERE.

Northern hemisphere, starboard tack.



"Being hove-to on the starboard tack, barometer falling:

"1. If the wind hauls by the compass to the right, or in the direction of the movement of the hands of a watch, the ship is to the right of the path of the center, in the dangerous semicircle, and should run close-hauled on the starboard tack, and keep this course until the barometer rises, and then run free.

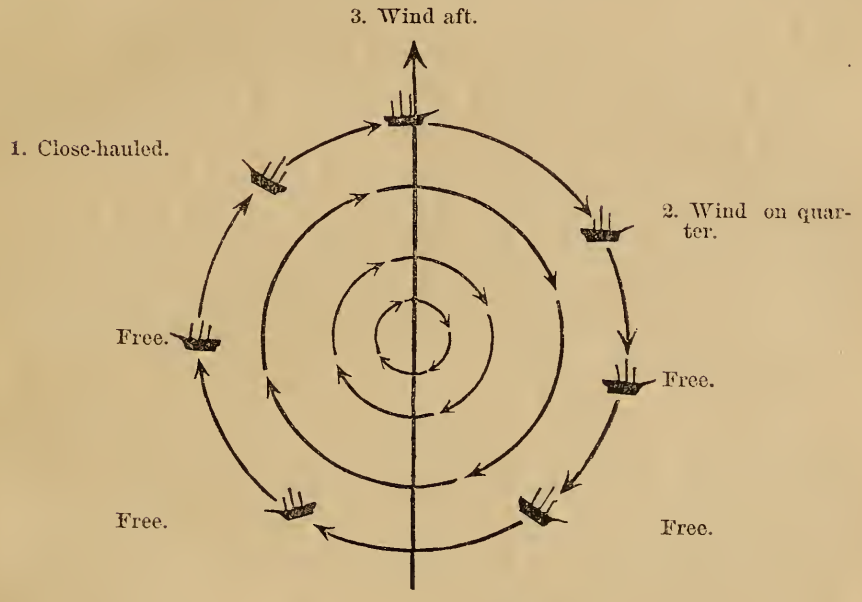
"2. If the wind hauls by the compass to the left, or con-

trary to the movement of the hands of a watch, the ship is to the left of the path of the center, in the manageable semicircle of the cyclone, and should run with the wind on the starboard quarter, and maintain this compass course during the ulterior changes of the wind until the barometer rises; from this time shape a course free.

"3. If the wind, as noted when hove-to, does not change its direction during the progressive fall of the barometer, the ship is in the path of the center, and should run with the wind aft and keep the same compass course on the starboard tack until the barometer rises; from this moment a course free should be maintained to the end of the storm."

MANEUVER IN HURRICANES IN THE SOUTHERN HEMISPHERE.

Southern hemisphere, port tack.



"Being hove-to on the port tack, the barometer falling:

"1. If the wind hauls by the compass to the left, in a direction contrary to the movement of the hands of a watch, the ship is to the left of the path of the center, in the dangerous semicircle; she should run close-hauled on the port tack, and preserve this course until the barometer rises, and then shape a course with the wind free.

"2. If the wind hauls by the compass to the right, in accordance with the movement of the hands of a watch, the ship is to the right of the path of the center, in the manageable semicircle of the storm, and should run with the wind on the port quarter and maintain this compass course during

the ulterior changes of the wind until the barometer rises; when shape a course free.

"3. If the wind, observed when hove-to, does not change its direction during the progressive fall of the barometer, the ship is in the path of the center, and should run before the wind and keep the same compass course on the port tack until the barometer rises; a course with the wind free should be constantly maintained until the end of the storm.

"These directions relative to maneuvers in hurricanes in the two hemispheres differ from those of page 19 of our memoir on hurricanes, tornadoes, typhoons, and tempests, as the maneuvers advised by Reid, in his recent work, *The Progress of the Development of the Law of Storms*, page 27, differ from those recommended in the two editions of his first work, *The Law of Storms*, which has been extolled by Piddington, Thom, &c.

"The latter work advised heaving-to on the port tack in the manageable semicircle of hurricanes in the northern hemisphere and on the starboard tack in the southern hemisphere, in order to avoid the danger of being taken aback in the shifts of wind. But this maneuver having the grave disadvantage of pushing the ship toward the center and precipitating her into a danger more certain and more formidable, Reid, struck by this disadvantage, advises at present to renounce this mode, and in all cases to take the starboard tack in the northern hemisphere and the port tack in the southern hemisphere.

"We are entirely of this opinion, which simplifies the maneuvers in reducing them to a question of direction and placing the tack out of the case, the more so as, the course with the wind on the quarter and the wind aft being substituted in the recent directions for hove-to on the opposite tacks in the manageable semicircle of hurricanes, ships need not fear being taken aback, for the shifts of wind are never so great at the commencement of a hurricane as to pass from aft forward.

"On the other hand, the variation of the wind arising from the ship penetrating the base of the hurricane is greater in a given time, as the penetration is greater or as the velocity of the translation of the hurricane is greater. Now, this velocity keeping back the wind from the manageable semicircle, the wind there is more feeble according to the rapidity with which the hurricane advances in its path; thence, the greatest variation in the direction of the wind which could be feared would be only from a wind comparatively light and by no means formidable; and if, on the

contrary, the wind is strong it varies but little, because the velocity of the translation is feeble, and then there is no danger of being taken aback, although in this case the violence of the wind in the manageable semicircle differs but little from that in the dangerous semicircle.

"We will add that the maneuver, wind aft, involves a great reduction of sail to manage the ship almost under bare poles if the wind is very violent, in order to reduce the speed of the ship and the impetus which she communicates to the waves, which would be likely to comb over aft if the speed were too great. It is always better to run the risk of shipping a few seas than to remain stationary, on all courses, except that, with the wind aft, it is necessary to make sail; otherwise the ship would be at the mercy of the waves."

That navigators may judge of their maneuver by the state of the sea, we will show the direction of the predominant wave on the different courses prescribed.

DIRECTION OF THE PREDOMINANT WAVE ON THE DIFFERENT COURSES.

In the northern hemisphere, starboard tack.

The ship being hove-to on the starboard tack:

On the course prescribed free, the predominant wave is on the starboard quarter.

In the dangerous semicircle:

On the constant course, close-hauled, the wave is on the starboard beam.

In the manageable semicircle:

1st. Wind aft	the wave is	on the port quarter.
2d. Wind on quarter		aft.
3d. Wind free		on the starboard quarter.
4th. Close-hauled		on the starboard beam.

In the southern hemisphere, port tack.

The ship being hove-to, port tack:

On the course prescribed, free, the predominant wave is on the port quarter.

In the dangerous semicircle.

On the constant course, close-hauled, the wave is on the port beam.

In the manageable semicircle:

1st. Wind aft.....	the wave is	on the starboard quarter.
2d. Wind on quarter..		aft.
3d. Wind free.....		on the port quarter.
4th. Close-hauled		on the port beam.

"According to the foregoing, the most unfavorable direction of the wave is that of close-hauled in the dangerous semicircle, but on this route, the ship being supported by the wind, the rolling is not likely to affect the spars; the pitching will be moderate and the helmsman must watch the waves and strive to avoid the shock of the heavy seas. This course should not be abandoned, for it is the only one by which to avoid future peril, and the skill of the helmsman may meet the present danger. The danger here mentioned should never make the mariner neglect the rules laid down. He should follow them at all hazards, whatever may be the state of the sea, for certainly his situation will become more dangerous the longer he delays to execute the maneuver which alone can secure his safety, by removing from the center of the hurricane."

The following is a *résumé*, for the two hemispheres, of the practical directions already given:

GENERAL REPRESENTATION OF THE MANEUVER IN HURRICANES, TYPHOONS, AND TEMPESTS.

As soon as a progressive fall of the barometer and increasing violence of the wind indicate the approach of a hurricane, all the necessary precautions should be taken; heave-to, so as to remain, as nearly as possible, stationary, or at least making very little progress, in order to observe the wind during the first depression of the barometer and to decide from it the course for escape as follows:

In the northern hemisphere, starboard tack:

The starboard tack should be taken equally in heaving-to at first as for the course of escape.

If, when hove-to, the barometer falling, the wind has not changed its direction, run with the wind aft and keep this original compass course.

If the wind hauls to the left, run with wind on quarter and keep this original compass course,	If the wind hauls to the right, run close-hauled and keep this course,

until the barometer rises.

From this moment, and as long as the wind is violent, follow the course free on the starboard tack.

In the southern hemisphere, port tack:

The port tack should be taken equally in heaving to at first, as for the course of escape.

If, when hove-to, the barometer falling, the wind has not changed its direction, run with the wind aft and keep this original compass course.

If the wind hauls to the left, run close-hauled and keep this compass course,	If the wind hauls to the right, run with wind on the quarter and keep this original compass course,

until the barometer rises.

From this moment, and as long as the wind continues violent, follow the course free on the port tack.

"These practical rules are general and independent of all conjecture upon the direction, the velocity, or the radius of the storm; they reduce the maneuver to a question of courses, the tack being constant and invariable in each hemisphere; they should be executed strictly, without any thought of the direction of the wave, for being influenced by the state of the sea might cause a false maneuver."